SUMMARY OF MEASUREMENTS OBTAINED DURING THE 1996 PASO DEL NORTE OZONE STUDY

FINAL REPORT
STI-996191-1603-FR

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Santa Rosa, CA

Prepared for:

U.S. Environmental Protection Agency, Region 6
Dallas, TX

Under Subcontract to:

Science Applications International Corporation
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Victor Paramo, SEMARNAP-INE
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Oscar Ibanez, Ciudad Juarez
Jesus Reynoso, El Paso
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1. INTRODUCTION AND BACKGROUND

During the summer of 1996, the United States Environmental Protection Agency (USEPA) sponsored an ozone field study in El Paso-Ciudad Juarez-Sunland Park to improve the general understanding of tropospheric ozone formation and transport in the local area. This work resulted from an agreement (Annex V to the 1983 La Paz Agreement) between the U.S. and Mexican governments to jointly monitor, gather emissions information, and model the El Paso-Ciudad Juarez-Sunland Park airshed in order to determine which control strategies would most efficiently improve air quality. Local and federal agencies from the U.S. and Mexico, as well as private contractors, collaborated in order to plan and carry out the study. This document summarizes the measurements performed during the 1996 Paso del Norte Ozone Study.

El Paso County fails to meet the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO), particulate matter (PM_{10}), and ozone (O_3). Adjoining Sunland Park exceeds the NAAQS for O_3 and PM_{10}. Juarez air quality exceeds the Mexican ambient standard for total suspended particulate (TSP), O_3, and CO. U.S. controls since the 1970s have significantly reduced volatile organic compound (VOC) emissions in El Paso, but this has not achieved attainment of the O_3 NAAQS in El Paso.

In response, a U.S.-Mexico Binational Air Workgroup (formed in 1984) has sponsored several major field studies since 1989 to better understand the causes of air pollution. These studies considered vehicles and traffic patterns in Juarez, gathered ambient and meteorological data, estimated Juarez industrial and area source emissions, and developed the first quality-assured air monitoring network in a Mexican border city, including five stations in Juarez (the first of which was on-line in 1990). Joint U.S.-Mexico studies since 1989 are expected to produce a reasonably good VOC and nitrogen oxides (NO_x) mobile sources inventory. Some emission factor data from Juarez industry have also been collected. Mexican industrial emissions data from the Sistema Nacional de Informacion de Fuentes Fijas (SNIFF) are available, and a first countrywide air emissions estimation methodology may be available soon. These bilateral efforts are continuing.

On the U.S. side, a 1991 agreement between the USEPA and the Texas Air Control Board (the precursor to the current Texas Natural Resource Conservation Commission, TNRCC) established 1999 as the target date for completion of all data collection and air modeling activities necessary to fulfill Annex V. Much of the data collection to date has centered on PM_{10} and CO, which have wintertime maxima in the airshed. Thus, a summertime field study was necessary to collect sufficient data for photochemical air dispersion modeling. To provide the necessary data, the EPA sponsored the 1996 Paso del Norte Ozone Study. The Study Operating Plan (Roberts et al., 1996) provides additional background. **Figure 1-1** illustrates the study area.

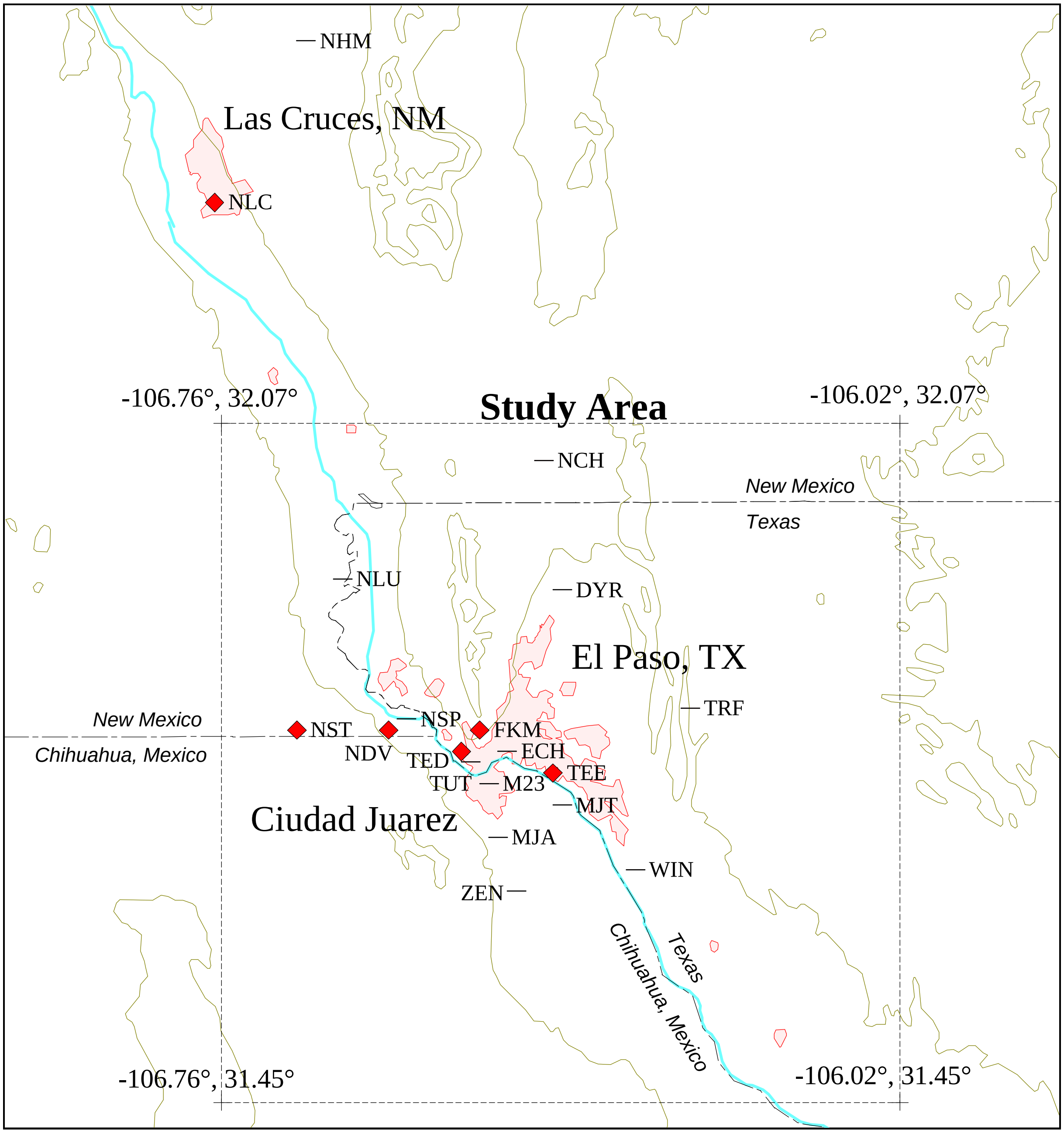


Figure 1-1. The 1996 Paso del Norte Ozone Study Area. (Diamonds denote air quality monitoring stations, see Tables 2-1 and 2-2 for details.)

The objectives of the project are to determine:

- The relative roles of VOC and NO_x emissions with respect to observed ozone in and downwind of El Paso-Ciudad Juarez-Sunland Park.

- The influence of regionally transported VOC, NO_x, and ozone on locally observed ozone levels.

- The relative contribution of VOC emitted by agricultural and other non-urban sources to high ozone occurrences.

- The contribution of ozone and precursors transported aloft in the atmosphere to the next day's surface ozone.

- The effect of mixing height and transport patterns during ozone episodes.

- The quality of local emission inventories.

- Photochemical input data and information for model evaluation.

- The variance in concentrations of VOC, NO_x, ozone, and other photochemical oxidation products as a function of meteorology and emissions.

To deal with these issues, the following specific tasks were recommended for the summer of 1996:

- Enhancement of the existing air quality monitoring network with the temporary addition of (a) four monitoring stations surrounding El Paso and (b) two NO_x analyzers at existing stations in Juarez.

- Addition of continuous upper-air meteorological sounding capabilities at three sites northwest, southeast, and in the center of El Paso.

- Deployment of an instrumented aircraft and hot-air balloon to measure the three-dimensional pollutant distribution on episode days as well as to provide an empirical basis for estimating inflow boundary conditions to the domain.

- Collection of hydrocarbon and carbonyl samples at surface air quality monitoring sites, near sources of interest, and on the aircraft and hot-air balloon.

- The use of existing sodars (operated by TNRCC) to determine lower-altitude mixing depths and wind speeds.

- The use of a tethersonde system in Juarez to further characterize the three-dimensional ozone concentration.

- Coordination and exchange of data and plans with other ongoing studies.

- Establishment of quality assurance plans that included systems and performance auditing.

- Development of a data archive to include routine air quality and meteorological observations from existing monitoring locations in the area, plus intensive measurements collected for the Paso del Norte Ozone Study.

- Integration of the information stemming from measurements with other aspects of this project, including data management, work on emissions, photochemical modeling, and quality assurance.

Most of these tasks have been successfully initiated. Air quality and meteorological measurements were conducted at four temporary sites in the area from late July through mid-September 1996. Observables (which vary by location) include ozone, nitric oxide (NO), the sum of nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbon and carbonyl compounds, wind speed, wind direction, ambient temperature, relative humidity, precipitation, and UV radiation. In addition, an existing network of 19 surface air quality and/or meteorological monitoring sites was in operation, including two Juarez sites that were enhanced with NO_x analyzers for this study. Three radar wind profilers with radio acoustic sounding systems (RASS) were installed for the duration of the study to provide hourly averaged vertical profiles of winds, virtual temperature, and related quantities such as the radar reflectivity structure parameter, which can be used to estimate mixing depth. Two existing sodars (operated by TNRCC) were in place to measure lower-altitude wind speeds and mixing depths. A light aircraft and a hot-air balloon were instrumented to measure ozone, NO, NO_x (or NO_y), hydrocarbons, carbonyls, meteorological observables, position, and altitude. Additionally, a tethersonde was in operation in Juarez during the study period.

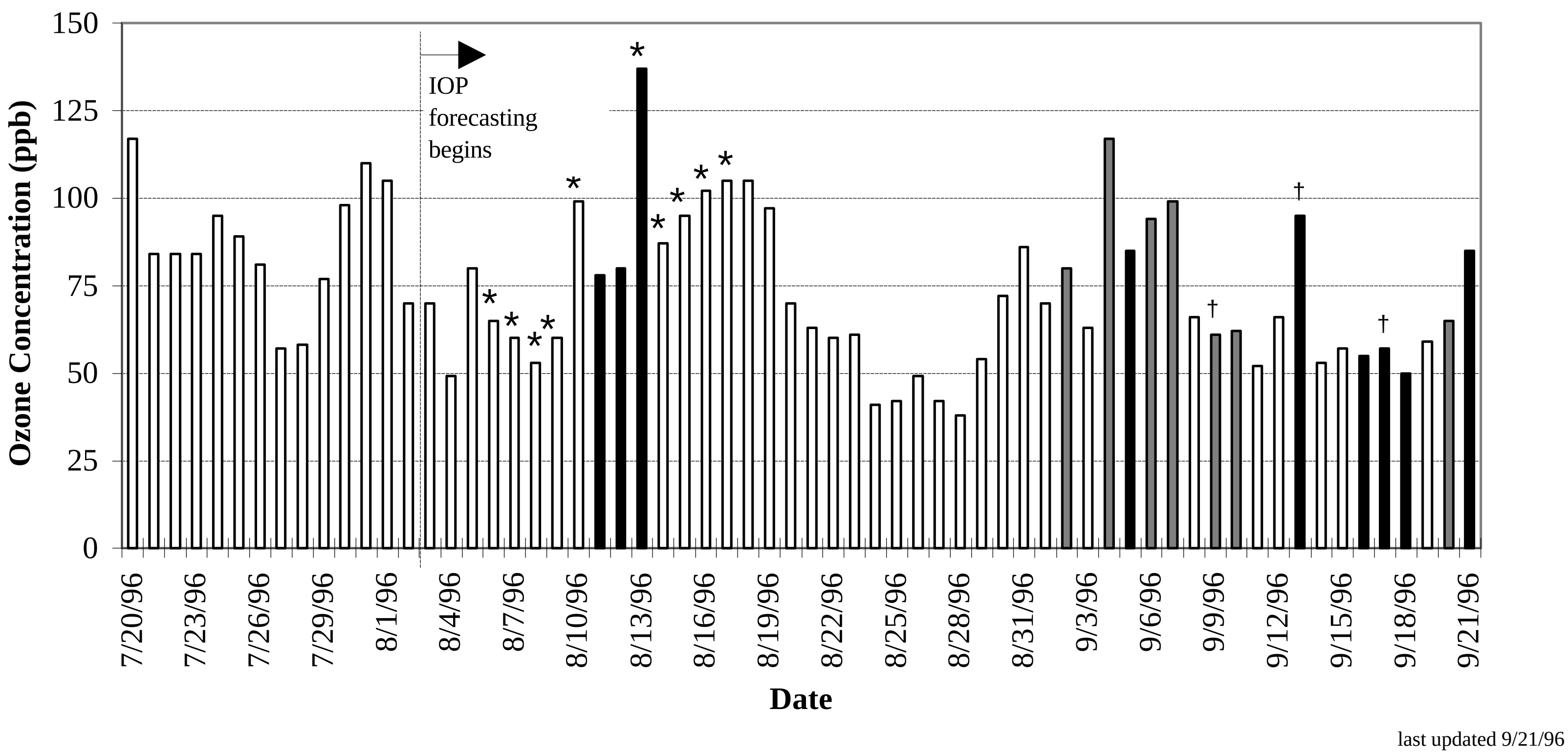
During the 1996 field study 9 days of intensive operations (IOPs) were identified, including August 11-13, September 5, 13, 16-18, and 21. For this report, an IOP is defined as a day when aircraft operations and surface hydrocarbon/carbonyl sampling occurred simultaneously. IOPs were called on a forecast basis when high levels of ozone were anticipated. During the IOPs, the aircraft operated and hydrocarbon (HC) and carbonyl compounds samples were collected at surface sites and on the aircraft. On non-IOP dates, various activities may have occurred, including hot-air balloon flights, surface hydrocarbon and/or carbonyl sampling, aircraft operation, and/or ozone tethersonde sampling. Section 2 discusses the dates on which these various activities occurred. For the duration of the study, surface meteorological and air quality data and upper air meteorological data were collected. **Table 1-1** provides a general schedule of major field study events.

Table 1-1. Schedule of major 1996 Paso del Norte Ozone Study activities.

Activity	Scheduled Date (1996)
Begin forecasting for IOPs (for practice)	July 17
Begin routine monitoring	July 21
Start of field study	July 21
Begin forecasting for IOPs	August 2
IOP window begins	August 3
End of intensive operations	September 21
End of routine operations	September 21-23

Figure 1-2 shows the maximum ozone concentration measured in the El Paso-Ciudad Juarez-Sunland Park area from July 20 through September 21, 1996; note that preliminary level 0 data were used and changes in the data may occur. The bold bars indicate IOPs. The half-tone bars indicate days on which supplemental aircraft flights occurred, the bars denoted with asterisks (*) indicate days on which hydrocarbon survey samples were collected, and the bars denoted with crosses (†) indicate balloon flight days.

The rest of this report summarizes field measurement activities and coordination (Section 2), the forecasting and decision-making protocol (Section 3), and details of the observed ozone concentrations and intensive measurements during IOPs (Section 4).



Bold Bars indicate IOPs, and halftone bars indicate additional days the aircraft operated (supplemental flights).
* - Supplemental surface hydrocarbon samples were collected.
†- Hot-air balloon operated.

Figure 1-2. Daily maximum hourly ozone concentrations in El Paso. Note that preliminary data were used and changes in the data may occur.

2. MEASUREMENTS AND COORDINATION

2.1 SUMMARY OF MEASUREMENTS

2.1.1 Surface Air Quality Measurements

Table 2-1 lists the positions (latitude, longitude, and elevation) and observables for monitoring sites that received temporary surface air quality and meteorological equipment for the 1996 Paso del Norte Ozone Study. AeroVironment, Inc. (AV) installed and operated the temporary monitoring equipment. Temporary equipment included Teco 42 NO_x analyzers (upgraded to Teco 42s analyzers) with lower detection limits (ldls) of 0.5 ppb and Dasibi 1003AH O_3 analyzers with ldls of 1 ppb. Between August 31 and September 6, the Teco 42s at Turf Road was inoperable. A ML8840 NO_x analyzer (ldl 2 ppb) substituted until the unit was repaired and replaced on September 10.

Table 2-2 gives the positions and observables for the previously existing network of surface air quality sites in El Paso-Ciudad Juarez-Sunland Park. **Figure 2-1** illustrates the locations of the air quality research stations in the El Paso-Ciudad Juarez-Sunland Park area.

2.1.2 Surface Hydrocarbon and Carbonyl Measurements

<u>**Surface Hydrocarbon Measurements**</u>

Hydrocarbon samples were collected in polished stainless steel canisters at 12 of the surface air quality and meteorological research sites. Routine hydrocarbon samples were collected at three of these sites as part of existing network operations. Canisters were collected on a 6-day schedule at El Paso CAMS 12 (UTEP) and El Paso CAMS 30 (Ascarate Park). A continuous GC analyzer was operated by TNRCC at the Chamizal Park site. Samples were collected by AV and Los Alamos National Laboratory (LANL) at 4 sites concurrent with IOP measurements (Winn Road, Turf Road, 20-30 Club, and El Paso CAMS 6) and at 5 sites as part of a special hydrocarbon survey (El Paso CAMS 30, Sunland Park, Zenco, Franklin Mountain, Dyer Street). For IOP sampling, two-hour samples were collected 5 times per day at 0600-0800, 0800-1000, 1000-1200, 1200-1400, and 1600-1800 MDT. For the hydrocarbon survey, two-hour samples were collected twice per day at various times. Between August 6 and August 17, the special hydrocarbon survey extended to several source-specific locations described as Chevron Tank, Chevron Tank South, Chevron Tank FCC, Police Station, Service Gas Co., Delmex (ITT), Delmex downwind, Propane Bus, Paint Shop, and Juarez Traffic (exact locations will be specified later). The purpose of the hydrocarbon survey was to provide supplementary or source-specific data.

Desert Research Institute (DRI) will analyze approximately 50 percent of the samples collected at Winn Road and Turf Road and from the aircraft and hot-air balloon. The US EPA (Bob Seila) and Instituto del Petroléo Mexicano (IMP) (Jose-Luis Arriaga) will analyze the

Table 2-1. Temporary air quality research stations operated during the 1996 Paso del Norte Ozone Study.

Site	ID	Latitude (decimal degrees)	Longitude (decimal degrees)	Elevation (m msl)	O_3	NO	NO_x	CO	PM	Hydrocarbons	CAR	WS	WD	T	RH	UV
Franklin Mountain	FKM	31.79	-106.48	1428	X	X	X			Aug 6-10[c]		X	X	X		
Turf Road	TRF	31.81	-106.25	1221	X	X	X			IOPs[b]	IOPs[b]	X	X	X	X	X
Dyer Street	DYR	31.92	-106.39	1195	X	X	X			Aug 6-10[c]		X	X	X		
Winn Road, El Paso	WIN	31.66	-106.31	1117	X	X	X			IOPs[b]	IOPs[b]	X	X	X	X	
20/30 Club	M23	31.74	-106.47	?	X	X[a]	X[a]			IOPs[a,b]		X	X	X	X	X
El Paso Downtown CAMS 6 (Campbell)	TED	31.7625	106.4869	1140	X	X	X	X		IOPs[a,b]						
Advance Transformer	MJA	31.69	-106.46	1167	X	X[a]	X[a]	X	X			X	X	X		

O_3 - Ozone, NO - Nitric oxide, NO_x - The sum of nitric oxide and nitrogen dioxide, CO - Carbon monoxide, CAR - Carbonyls, WS - Wind speed, WD - Wind direction, T - Temperature, RH - Relative humidity, UV - UV radiation.

[a] Temporary equipment installed at existing sites; all other equipment at these sites is permanent.

[b] Samples collected during intensive operating period (IOPs); five 2-hour samples per day.

[c] Two 2-hour samples per day.

Table 2-2. Permanent air quality research stations operated during the 1996 Paso del Norte Ozone Study. (Table only shows sites where O_3, NO_x, and/or hydrocarbons were observed.)

Site	ID	Latitude (decimal degrees)	Longitude (decimal degrees)	Elevation (m msl)	AIRS #	O_3	NO	NO_x	CO	PM	Hydrocarbons	Surf Met
La Union, NM	NLU	31.9306	106.6306	1204	350130008	X						X
University Avenue, Las Cruces, NM	NLC	32.2814	106.7672	1188	350131012	X			X			X
Sunland Park City Yard, NM	NSP	31.7958	106.5575	1200	350130017	X				X	Aug 6, 8-10 [a,b]	X
Las Cruces Holman, NM	NHM	32.4247	106.6742	1189	350130019	X	X	X		X		X
Chaparral Elem., Chaparral, NM	NCH	32.0408	106.4092	1249	350130020	X	X	X		X		X
Desert View Elem., Sunland Park, NM	NDV	31.7961	106.5839	1209	350130021	X	X	X		X		X
Santa Teresa Intl. Border Crossing, NM	NST	31.7878	106.6828	1256	350130022	X			X	X		X
El Paso Dntn. CAMS 6 (Campbell)[a]	TED	31.7625	106.4869	1140	481410027	X	X	X	X		IOP [a]	X
El Paso East CAMS 30 (Ascarate Park)	TEE	31.7536	106.4042	1126	481410028	X			X		Aug 6-10 [a,b] & $^{1}/_{6}$	X
El Paso UTEP CAMS 12	TUT	31.7683	106.5006	1143	481410037	X	X	X	X		$^{1}/_{6}$	X
Chamizal Park	ECH	31.7681	106.4542	1128	481410044	X			X	X	Hourly	X
Tecno (Chihuahua State Technical Inst.)	MJT	31.7156	106.3942	1123	800060001	X			X	X		X
Advance Transformer	MJA	31.6900	106.4597	1167	800060004	X	X[a]	X[a]	X	X		X
20-30 Club	M23	31.7375	106.4673	?	800060006	X	X[a]	X[a]			IOP [a]	X
Zenco	ZEN	31.6381	106.4431	1183	800060003					X	Aug 15-16 [a,b]	

O_3 - Ozone, NO - Nitric oxide, NO_x - The sum of nitric oxide and nitrogen dioxide, CO - Carbon monoxide, PM - Particulate matter, Surf Met - Surface meteorological variables, Hourly - Continuous hourly sampling (auto-GC), $^{1}/_{6}$ - Eight 3-hour samples collected every 6 days, IOP - Five 2-hour samples collected on IOP days.

a Temporary equipment installed at existing sites; all other equipment is permanent.

b Two 2-hour samples per day.

Figure 2-1. Locations of surface air quality and meteorological monitoring sites during the 1996 Paso del Norte Ozone Study.

samples collected at 20-30 Club and CAMS 6. Prior to shipment to the field, DRI and Biospherics Research Corporation (BRC) certified the polished stainless-steel canisters as free of contamination. The laboratory analytical process is based on gas chromatography (GC) with a flame-ionization detector (FID) to quantify each hydrocarbon identified, plus CO and total non-methane hydrocarbons (TO-12). Individual compounds will be resolved with up to 10 carbon atoms, and will include those emitted by vegetation such as isoprene and alpha- and beta-pinene. Compound identification is confirmed intermittently via mass spectrometry. The hydrocarbon analysis process also includes blanks, duplicate analyses, duplicate samples collected at the same time, and some samples exchanged with EPA and other laboratories.

Surface Carbonyl Measurements

The use of carbon sampling cartridges is the most widely used methodology to measure carbonyls. However, conflicting evidence exists in literature and in discussions among technical experts, questioning specific aspects such as: (1) substrate, (2) absorption reagent, (3) substrate/reagent ratios, (4) potential ozone interference, (5) blank levels and variability, (6) possible biases due to ozone removal procedures, and (7) concentrations of carbonyl compounds with three or more carbon atoms (C_3+). Even though these issues have not been fully resolved, existing data suggest that the full range of carbonyl compounds may be important in the Southwest (Fung, 1994; Zielinska, 1996; Martin and Popp, 1996). Therefore, carbonyls through C7 were measured during the 1996 Paso del Norte Ozone Study. Carbonyl samples were collected using dinitrophenylhydrazine (DNPH)-impregnated C18 Sep-Pak cartridges without ozone scrubbers, coated by DRI. During IOPs, two-hour samples were collected five times per day at 0600-0800, 0800-1000, 1000-1200, and 1200-1400, and 1600-1800 MDT at two surface air quality sites (Turf Road and Winn Road) by AV. Similar two-hour samples were collected at the 20-30 Club during IOPs after September 5 by LANL. AV and LANL shipped the samples for analyses to DRI. All cartridges were stored refrigerated and shipped cool. DRI will analyze approximately 50 percent of the samples collected. The laboratory analytical process includes high performance liquid chromatography (HPLC) to separate and identify the carbonyl compounds in an acetonitrile extract of each cartridge. The compounds include: formaldehyde, acetaldehyde, acetone, propanal, methyl ethyl ketone, butanal, pentanal, and C5, C6, and C7 carbonyls.

To better understand uncertainties, a large number (about 10 to 20 percent) of field blanks were collected at all sites. Some of these blanks were exposed as a second cartridge in series downstream of the primary cartridge in order to determine whether the scrubbing efficiency was close to unity. If so, this second cartridge serves as a dynamic field blank. If not, true scrubbing efficiencies can be evaluated and accounted for.

2.1.3 Upper-Air and Surface Meteorological Measurements

Table 2-3 lists the project's radar profiler/RASS (radio acoustic sounding system), surface meteorological sites, sodars, and their positions (latitude and longitude). The locations of these sites are shown in **Figure 2-2**. John Archuleta of Los Alamos National Laboratory (LANL) and Lin Lindsey of Sonoma Technology, Inc. (STI) were responsible for operation of the three radar profilers. TNRCC operated two sodars (contact: Ed Michel).

Table 2-3. Upper-air and surface meteorological measurement sites used during the 1996 Paso del Norte Ozone Study.

Site	ID	Equipment	Latitude (Decimal degrees)	Longitude (Decimal degrees)
Bustamante Wastewater Plant	ELE	RP/RASS[a,b]	31.65	-106.32
Delta-Haskel Wastewater Plant	ELD	RP/RASS[a,c] sodar[d]	31.76	-106.43
Texas D.o.T.	ELW	RP/RASS[a,b]	31.89	-106.6
Sun Metro	SUN	sodar[d]	31.759	-106.501
Lower Valley Water Well 414	LVW	sodar	31.70	-106.35
La Union, NM	NLU	surface met	31.9306	-106.6306
University Avenue, Las Cruces, NM	NLC	surface met	32.2814	-106.7672
Sunland Park City Yard, NM	NSP	surface met	31.7958	-106.5575
Las Cruces Holman, NM	NHM	surface met	32.4247	-106.6742
Chaparral Elem., Chaparral, NM	NCH	surface met	32.0408	-106.4092
Desert View Elem., Sunland Park, NM	NDV	surface met	31.7961	-106.5839
Santa Teresa Intl. Border Crossing, NM	NST	surface met	31.7878	-106.6828
El Paso Tillman, TX	TIL	surface met	31.7569	-106.4828
El Paso Downtown CAMS 6 (Campbell), TX	TED	surface met	31.7625	-106.4869
El Paso East CAMS 30 (Ascarate Park), TX	TEE	surface met	31.7536	-106.4042
Ivanhoe Fire Station	IVH	surface met	31.7881	-106.3217
El Paso UTEP CAMS 12	TUT	surface met	31.7683	-106.5006
Chamizal Park	ECH	surface met	31.7681	-106.4542
Lindbergh Elementary School	LIN	surface met	31.8606	-106.5864
Tecno (Chihuahua State Technical Institute)	MJT	surface met	31.7156	-106.3942
Advance Transformer	MJA	surface met	31.6900	-106.4597
20-30 Club	M23	surface met	31.7375	-106.4673

[a] Radar profiler (RP) with RASS systems measure upper-air wind speed, wind direction, and virtual temperature. Radar sites also have surface meteorological measurements of wind speed, wind direction, temperature, pressure, relative humidity, total solar radiation, and precipitation.

[b] Operated by STI.

[c] Operated by LANL.

[d] Sodar was moved from Sun Metro to Delta-Haskel on September 8.

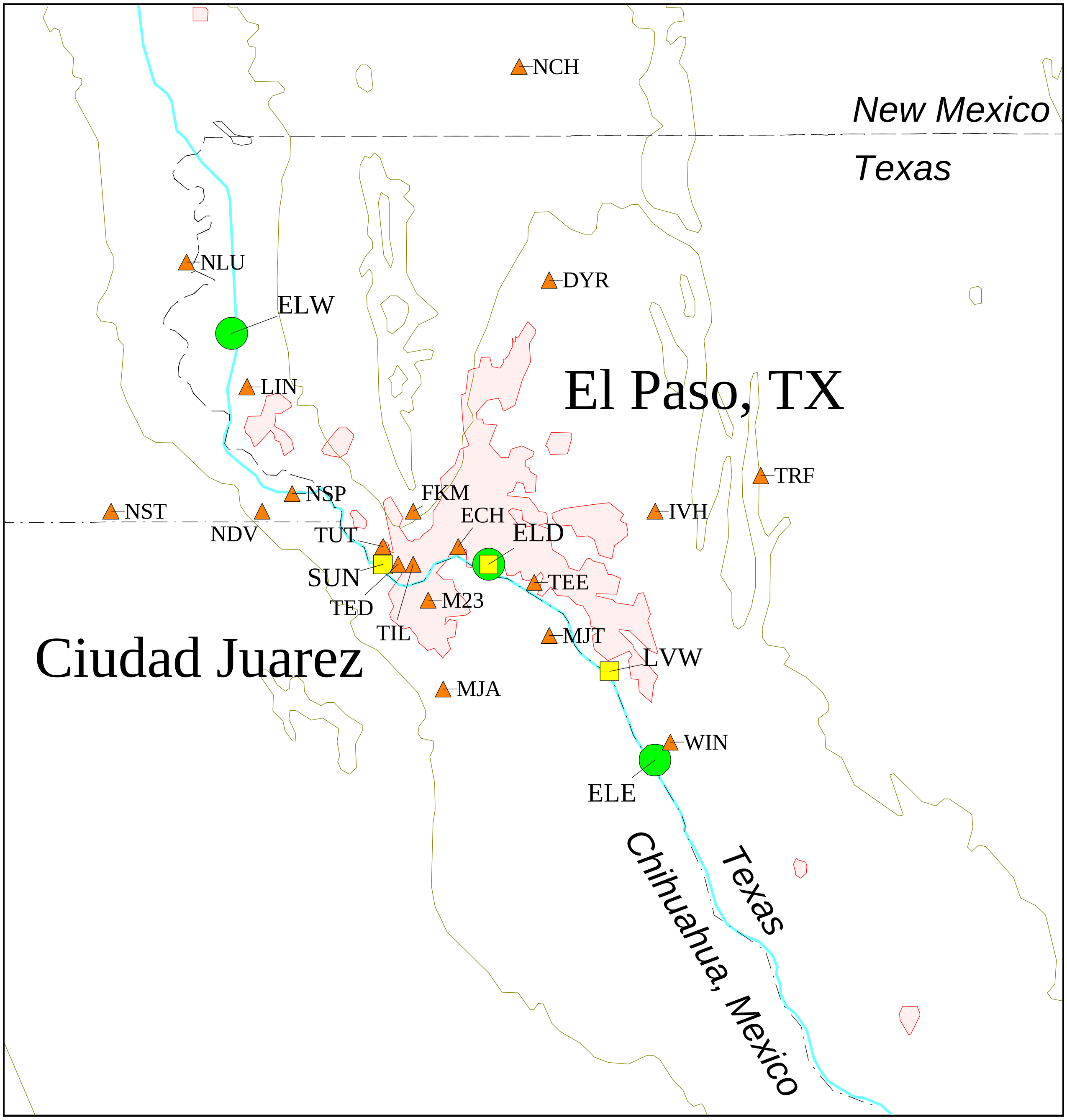


Figure 2-2. Locations of radar profilers with RASS and surface met (circles), surface met stations (triangles), and sodars (squares).

2.1.4 Aircraft and Hot Air Balloon Measurements

The aircraft and hot-air balloon measurements focused on issues of transport and pollutant distribution rather than photochemistry. A twin-engine aircraft operated on IOP days and some additional dates from early August through mid-September. The hot-air balloon operated on three dates (September 9, 13, and 16) and allowed the collection of data at low altitudes over the urban areas where the aircraft was prohibited. The specific aims of the aircraft and balloon measurements included:

- Obtain information on the concentrations, variability, and fluxes of ozone and its precursors across the upwind boundaries of the El Paso area.

- Document the vertical distribution of ozone and precursors from which the total reservoir of ozone in the boundary layer is derived.

- Determine whether ozone is stored aloft overnight and available for entrainment as the mixing layer deepens.

- Document the relationship between boundary layer dynamics and ozone concentrations. Determine whether the midday increase in mixing height entrains ozone and increases surface concentrations or instead dilutes the surface concentrations.

- Estimate the spatial variability of pollutants on the scale of model grid volumes.

- Provide initial and boundary condition data (including the upper boundary) for model inputs.

To accomplish these aims the aircraft was equipped to measure the following observables:

- Ozone
- NO, NO_y with a lower detection limit of about 0.2 ppb
- Hydrocarbons and CO using canisters (3 or 5 per flight)
- Carbonyl samples collected in Teflon bags (3 or 5 per flight) and transferred to DNPH cartridges
- Temperature
- Dew point
- Position, altitude

The hot air balloon was equipped to measure:

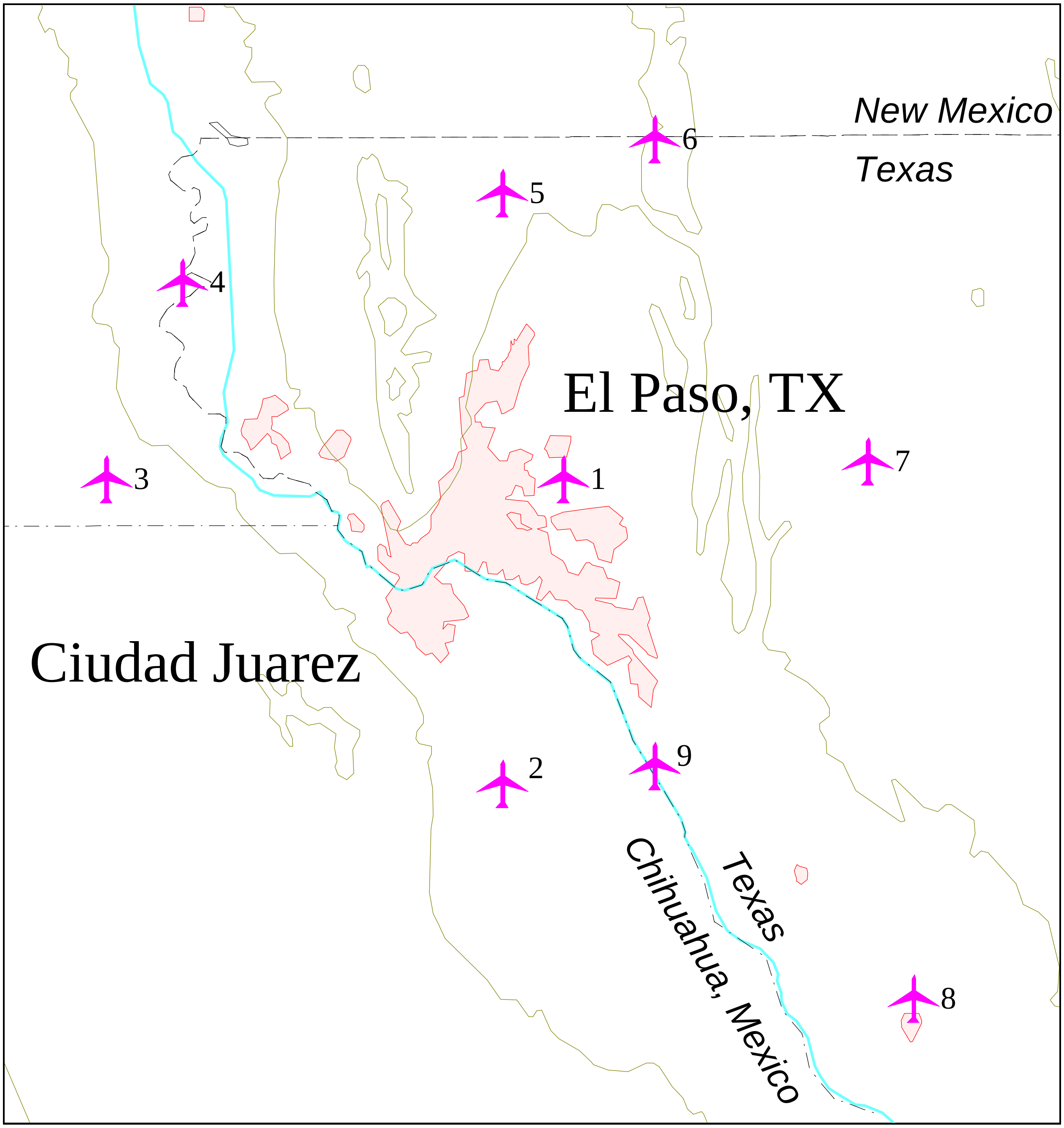
- Ozone
- NO, NO_x with a lower detectable limit of about 0.2 ppb
- Hydrocarbon canisters (2 to 4 per flight)
- Carbonyl samples collected in Teflon bags (2 to 4 per flight) and transferred to DNPH cartridges
- Temperature
- Position, altitude

The base of operations for the aircraft was the El Paso airport. The aircraft flights consisted of traverses low in the boundary layer with occasional dips to the surface and spirals from the surface to the top of the boundary layer (or vice-versa). **Figure 2-3** illustrates the aircraft flight patterns. **Table 2-4** provides further details. On IOP days (with the exception of August 11 and September 16-18), the aircraft typically made an early morning flight (0530-0830 MDT) and a midday flight (1100-1400 MDT). On August 11-12, night flights occurred from 2100-2330 MDT. During IOP and night flights, spirals were performed in the following order (see Figure 2-3): spiral #s 1, 2, 3, 4, 5, 6, 7, 8, 9, and 1. On September 2, 4, 6, 7, 16-18, and 20 supplemental flights were conducted from 1030-1230 MDT. During the supplemental flights, spirals were performed in the following order: spiral #s 1, 2, 9, 1, 7, 5, 4, and 1. Morning flights documented initial conditions, overnight carryover, and morning vertical distributions. The early parts of the morning flights and the night flights were intended to be representative of the conditions during the night. The mid-day flights documented air quality during peak ozone and mixed boundary layer conditions. During IOP flights, one hydrocarbon and one carbonyl sample were collected during 5 of the flight spirals. During supplemental flights, one hydrocarbon and one carbonyl sample were collected each time spiral 1 was performed.

The flight pattern of the hot-air balloon was governed by the wind direction, rather than predetermination. Balloon flights occurred on September 9, 13, and 17. The balloon launched from Bowie High School on September 9 and 13, and from the UTEP Sun Bowl parking lot on September 17. The Balloon flights were approximately 2 hours in length, occurring early in the morning and reaching a maximum altitude of about 600 meters agl (flight paths will be illustrated in the Balloon Final Report).

2.1.5 Special Tests

Tethersonde measurements in Juarez: Chuck Bruce and Al Jelinek of New Mexico State University conducted measurements using a tethered balloon in Juarez on August 12-14 and on September 9, 13, 17, 18, and 21. Observables included O_3, NO_x, NO_2, and meteorological variables up to 150 meters. Typically, the procedure included a daybreak balloon flight near



IOP flight pattern (in order): Spiral #s 1, 2, 3, 4, 5, 6, 7, 8, 9, and 1. Supplemental flight pattern: Spiral #s 1, 2, 9, 1, 7, 5, 4, and 1.

Figure 2-3. Illustration of aircraft flight patterns during the 1996 Paso del Norte Ozone Study. (Symbols indicate the locations of surface-to-boundary layer spirals.)

Table 2-4. Details of the aircraft flight pattern.

Spiral No.	Ground Elevation (meters msl)	Description
Initial flight at Spiral 1	1206	Surface up to 2740 m HCs and Cnyls 1360 to 1664 m
Subsequent flights at Spiral 1	1206	3050 m down to a low pass HCs and Cnyls 3050 m to 2740 m
2	1171	2740 m down to a low pass HCs and Cnyls 1630 to 1322 m
3	1255	2740 m down to a low pass
4	1248	Low pass up to 2740 m HCs and Cnyls 1300 to 1600 m
5	1224	2740 m down to a low pass
6	1326	Low pass up to 2740 m
7	1230	2740 m down to a low pass HCs and Cnyls 1690 to 1380 m
8	1121	2740 m down to a low pass
9	1116	Low pass up to 3050 m HCs and Cnyls 1270 m to 1570 m

downtown Juarez followed by a spatial survey of ozone concentrations over a large downwind area. Weather permitting, afternoon flights were also conducted (in varying locations on August 13, 14, and September 21), followed by additional downwind spatial ozone surveys. Tethered balloon launch sites included (1) the baseball stadium at the intersection of Americas Avenue and Guerrero (near the 20-30 Club) site, (2) near the Advanced Transformer (MJA) air quality monitoring site, and (4) the University Sports Stadium near the United States border. Further details will be available in the Tethersonde Final Report.

Fuel Samples

In addition, liquid gasoline and diesel fuel samples were collected at stations in El Paso and Juarez, including all grades and a range of brands. The samples will be analyzed for Reid Vapor Pressure (RVP) by the El Paso City-County Health Department, and for hydrocarbon speciation by Bob Seila at EPA.

2.1.6 Summary Schedule of Field Measurements

Table 2-5 summarizes the dates on which various field activities occurred. Note that this is preliminary and may contain errors. Note that the IOP period was originally planned

Table 2-5. Summary of activities that occurred during the 1996 Paso del Norte Ozone Study.

Date	IOP	IOP HCs & Carbonyls.	Aircraft	HC Survey	Hot-Air Balloon	Juarez Tethersonde.	Comments
July 21							All temporary sites on-line: WIN 7/18, TRF 7/19, M23 NO_x & MJA NO_x 7/20, FKM & DYR 7/21.
July 30							All temporary radar profilers on-line: ELE 7/8, ELD 7/11, ELW 7/30
August 3							IOP period begins
August 6				x			HC Survey : TEE, FKM, DYR, NSP
August 7				x			HC Survey : TEE, FKM, DYR
August 8				x			HC Survey : TEE, FKM, DYR, NSP
August 9				x			HC Survey : TEE, FKM, DYR, NSP
August 10				x			HC Survey : TEE, FKM, DYR, NSP
August 11	x	x	n				
August 12	x	x	ia, ip, n			am	
August 13	x	x	ia, ip	x		am, pm	HC Survey : Chevron Tank, Police Sta
August 14		x		x		am, pm	HC Survey : Chevron Tank, Police Sta, Paintshop, Service Gas Co.
August 15				x			HC Survey : Chevron Tank, Police Sta, Zenco, Delmex, Juarez Traffic, Propane Bus
August 16				x			HC Survey : Police Sta, Zenco, Chevron South
August 17				x			HC Survey : Chevron FCC
August 18					test flight		
September 2			suppl.				NO_x at TRF down (since 8/31)
September 4			suppl.				NO_x at TRF down
September 5	x	x	ia, ip				NO_x at TRF down
September 6			suppl.				ML8840 NO_x analyzer installed at TRF
September 7			suppl.				
September 9			suppl.		x	am	
September 10			suppl.				Teco 42s reinstalled at TRF
September 13	x	x	ip		x	am	
September 16	x	x	suppl.				
September 17	x	x	suppl.		x	am	
September 18	x	x	suppl.			am	
September 20			suppl.				
September 21	x	x	ia, ip			am, pm	IOP period ends

n- Night flight, ia - IOP morning flight, ip - IOP afternoon flight, suppl. - Supplemental flight, am - morning tethered balloon flight and downwind survey, pm - afternoon tethered balloon flight and downwind survey.

for August 3-September 13. Since there were so few days with high ozone concentrations by September 13, the IOP period was extended until September 21, 1996.

2.1.7 Quality Assurance

Quality auditing was performed by Desert Research Institute (DRI). In accordance with the overall quality assurance plan Bowen (1996a, 1996b**)** the following tasks were identified:

- Confirm that data quality objectives are commensurate with the aims of the project.

- Review Standard Operating Procedures (SOPs) and quality control tests to determine whether they are sufficient to meet the data quality objectives.

- Perform audits to determine whether staff qualifications and activities are consistent with established data quality objectives.

- Review the field, laboratory, parameter derivation, and data archiving processes.

- Review quality control test results.

  The reviews will key on the following points.
  - Stated accuracies and precisions will be compared with the requirements of the data analysis and of the models that will be used.

  - Adequacy of the measurement methods in terms of the intended use of the data will be assessed and potential problems for obtaining adequate results will be determined.

  - Plans for instrument calibrations will be reviewed with emphasis on assuring traceability to acceptable reference standards.

  - SOPs are complete and contain adequate provisions for quality control and data validation.

- Develop procedures that will enable the auditor to verify that planned quality control procedures are being followed and that collected data are meeting specified tolerances.

- Audit the sampling system components in place during the 1996 Paso del Norte Ozone Study at the four temporary surface air quality and meteorological research sites, three radar profiler/RASS upper-air and surface meteorological sites, one aircraft, the hot-air balloon, and the tethersonde.

- Coordinate resolution of problems found during the audits and intercomparisons.

2.2 COORDINATION AMONG PASO DEL NORTE OZONE STUDY ORGANIZATIONS AND INDIVIDUALS

Each measurement contractor maintained regular communications with the Observations Coordinator or operations center. **Table 2-6** lists the telephone and fax numbers of several individuals involved in the field study. Instrument problems were reported as soon as possible; reports provided as much information as possible, including information on the location of the problem, the type of problem, and the parameter(s) affected, the proposed solutions to the problem, and the expected length of time the equipment was expected to be inoperative. Additional responsibilities of key individuals during the field measurements are listed below. If any of the field measurement personnel had problems, they contacted the Observations Coordinator at the earliest possible time.

Observations Coordination: Paul Roberts, assisted by Dana Coe, STI, set up an operations center in Santa Rosa, CA for maintaining contact with the study participants. The Observations Coordinator monitored the progress of the study and the readiness of the participants, and provided oversight and assistance to the participants to solve problems. Paul Roberts coordinated the daily decision-making process, made the daily decision on IOP sampling and made available required information and sampling decisions to the study investigators.

Surface air quality and meteorology: Jerry Thelan and David Pankratz, AV, managed the surface air quality and meteorology observations, kept the Observations Coordinator informed of the operational status of their air quality and meteorological equipment, supervised the collection of hydrocarbon and carbonyl samples for later laboratory analysis during IOPs, and provided equipment status and previous day's maximum ozone concentrations by 1230 MDT daily. Jose-Luis Arriaga, IMP, Bob Seila, EPA, and Clay Heskitt, LANL, were responsible for the supplemental hydrocarbon sampling and for hydrocarbon and carbonyl sampling at the 20-30 Club and Advance Transformer. Barbara Zielinska, DRI, provided hydrocarbon cans, carbonyl cartridges, and sampling systems and supervised the collection of heavy hydrocarbon samples. AV, El Paso City-County Health and Environmental Department, TNRCC, and the New Mexico Environment Department provided the previous day's maximum 1-hour average ozone concentrations to the Observations Coordinator by 1230 MDT.

Upper-air and surface meteorology: John Archuleta, LANL, and C.G. (Lin) Lindsey, STI, managed the operation of the radar profiler/RASS systems, provided operational status of the radar profiler/RASS equipment and surface meteorological equipment to the Observations Coordinator by 1230 MDT daily, and provided upper-air wind and temperature data to the Observations Coordinator as needed.

Aircraft: Jerry Anderson, STI, managed the aircraft operations. He provided operational status of the aircraft and equipment by 1300 MDT daily; and supervised the preparation of the aircraft for field sampling and the aircraft sampling flights.

Table 2-6. Individuals involved with the 1996 Paso del Norte Ozone Study.

Name	Organization	Telephone	Fax
Jim Yarborough, Bob Seila	USEPA (Dallas office) USEPA (Research Triangle Park office)	(214)665-7232 (919)541-2214	(214)665-7263 (919)547-4787
Mark Saeger	Science Applications International Corp.	(919)544-3856	(919)544-4175
Paul Roberts, C.G. (Lin) Lindsay, Jerry Anderson, Bastian Schoell	Sonoma Technology, Inc.	(707) 527-9372	(707)527-9398
Jerry Thelan, David Pankratz	AeroVironment	(818)357-9983	(818)357-0989
Ed Michel, Brian Lambeth, Victor Valenzuela	Texas Natural Resources Conservation Commission	(512)239-1384 (915)778-9634	(512)239-0696 (915)778-4576
Jesus Reynoso, Henry Del Rio	El Paso City-County Health and Environmental District	(915)771-5800	(915)771-5714
Clay Heskitt John Archuleta	Los Alamos National Labs	(505)667-4418 (505)522-9333	(505)246-6001 (505)521-9619
Steve Watson, Russ Price	University of Utah	(801)771-2016	(801)777-6179
Chuck Bruce, Al Jelinek	New Mexico State University	(505)522-9330	(505)646-1934
Erik Aaboe, Josephine Ball	New Mexico Environment Department	(505)827-0031	(505)827-0045
Barbara Zielinska, Dick Egami, Dale Crow, John Bowen	Desert Research Institute	(702)677-3198	(702)677-3157
Jose-Luis Arriaga	Instituto del Petroléo Mexicano	011-5216-16-7625	

Hot Air Balloon: Steve Watson and Russ Price, University of Utah, prepared the hot-air balloon for operation. Steve Watson piloted the balloon while Russ Price led the chase/recovery crew. Bastian Schoell, STI, prepared and operated the balloon sampling equipment during flight.

Tethersonde: Chuck Bruce, NMSU, planned and managed the tethersonde measurements in Juarez.

Meteorological Forecasting: Brian Lambeth, TNRCC, and Tim Dye and Scott Ray, STI, provided daily meteorological and air quality forecasts for the study region by 1300 MDT; provided both current and forecast products; and provided other relevant information (e.g., satellite images, trajectory forecasts, severe weather probabilities). Some of these products were faxed to the Observations Coordinator each day, while other information was obtained by the Observations Coordinator or his staff during daily conference calls. Details about the forecasting methodology are addressed in the Section 3.

2.3 DAILY STATUS REPORT AND YESTERDAY'S AIR QUALITY

Each day by 1230 MDT, equipment status and data reports were prepared and provided to the Observations Coordinator for use in forecasting and decision-making. **Figures 2-4a to 2-4e** show examples of the daily status and data reports that were provided by the different organizations.

STATUS OF EL PASO GROUND NETWORK OPERATED BY AEROVIRONMENT ENVIRONMENTAL SERVICES INCORPORATED

STATUS OF EQUIPMENT AS OF: 1100 MST 8/13/96
NUMBER OF VOC/CARBONYL SAMPLES COLLECTED 0600-2200 HRS PREVIOUS DAY

SITE	Ozone	NO/NO2/NOx	VOC/ # of samples	Carbonyl/ # of samples	WS	WD	T	RH	SR	Modem Connection
1 Franklin Mtn	OK	OK	Not at Site	Not at Site	OK	OK	OK	Not at Site	Not at Site	OK
2 Turf Road	OK	OK	5	5	OK	OK	OK	OK	Ok	OK
3 Dyer Street	OK	OK	Not at Site	Not at Site	OK	OK	OK	Not at Site	Not at Site	OK
4 Winn	OK	OK	5	5*	OK	OK	OK	OK	OK	Not Made
5 2030 Club	OK	OK	Not at Site	Not at Site	Data not avail to A	Data not avail to A	Data not avail to A	Data not avail to A	Not at Site	OK
6 Advance	OK	OK	Not at Site	Not at Sie	Data not avail to A	Data not avail to A	Data not avail to A	Not at Site	Not at Site	OK

It looks like the carbonyl samples collected at site 4 can not be sorted out as to which one were collected at what time; we reprogrammed the timer last night. Our field techs will talk to DRI directly to see if the collected samples can be identified
The Franklin Mtn. NOx analyzer is looking real good.
A new modem will be installed in Winn on Tuesday.
All VOC and caronyl samplers are running.

Figure 2-4a. Example daily status report submitted by AeroVironment.

STATUS OF EL PASO GROUND NETWORK OPERATED BY AEROVIRONMENT ENVIRONMENTAL SERVICES INCORPORATED

		Julian Date	Hour ending	WS m/sec	WD deg	Sigma deg	T deg C	RH %	NO ppb	NO2 ppb	NOx ppb	O3 ppb	SR watt/m^2
Dyer: Site 3													
222	1996	226	200	1	152	41	21		-2	12	14	12	N/A
222	1996	226	300	1	94	61	20		-3	9	10	15	N/A
222	1996	226	400	1	348	12	19		-2	9	10	12	N/A
222	1996	226	500	1	10	48	19		3	9	15	11	N/A
222	1996	226	600	1	358	20	18		18	9	31	10	N/A
222	1996	226	700	1	14	37	20		18	11	32	13	N/A
222	1996	226	800	1	68	49	24		7	7	18	26	N/A
222	1996	226	900	1	258	64	27		0	4	7	40	N/A
222	1996	226	1000	2	176	34	29		-1	5	7	51	N/A
222	1996	226	1100	3	165	27	31		-2	3	4	67	N/A
222	1996	226	1200	2	148	47	32		-4	1	0	81	N/A
222	1996	226	1300	2	183	64	33		-4	0	0	94	N/A
222	1996	226	1400	2	148	79	34		-4	-1	-1	90	N/A
222	1996	226	1500	2	196	74	34		-4	-1	-2	87	N/A
222	1996	226	1600	2	211	44	35		Z/S	Z/S	Z/S	Z/S	N/A
222	1996	226	1700	2	246	37	35		Z/S	Z/S	Z/S	Z/S	N/A
222	1996	226	1800	3	209	23	34		-4	1	0	71	N/A
222	1996	226	1900	2	195	10	32		-4	5	5	67	N/A
222	1996	226	2000	2	187	14	29		-4	17	17	36	N/A
222	1996	226	2100	1	187	23	28		-2	23	25	16	N/A
222	1996	226	2200	2	349	9	25		4	17	25	12	N/A
222	1996	226	2300	1	101	73	24		0	15	19	11	N/A
222	1996	226	2400	1	182	14	25		-3	8	8	31	N/A
222	1996	227	100	2	183	28	24		Z/S	Z/S	Z/S	Z/S	N/A
222	1996	227	200	0	211	72	22		-4	2	2	26	N/A
222	1996	227	300	0	94	33	21		-4	5	5	20	N/A
222	1996	227	400	1	203	15	21		-2	11	12	13	N/A
222	1996	227	500	1	172	14	20		-3	15	16	15	N/A
222	1996	227	600	2	163	16	20		-2	15	17	14	N/A
222	1996	227	700	2	169	10	22		1	13	18	22	N/A
222	1996	227	800	3	167	11	25		-2	5	7	40	N/A
222	1996	227	900	4	171	19	27		-2	4	6	47	N/A
													N/A
													N/A

Figure 2-4b. Example daily data sheet submitted by AeroVironment.

PLEASE FAX TO STI WEATHER OPERATIONS CENTER
FAX # 707-527-9398

MAXIMUM OBSERVED HOURLY OZONE

DATE OBSERVED: 8/13/96   TIME ZONE (circle): Mountain Standard or Mountain Daylight

	La Union (#0008)	Las Cruces Univ. (#1012)	Sunland Park (#0017)	Las Cruces Holman (#0019)	Chaparral Elementary (#0020)	Desert View Elementary (#0021)	Santa Teresa Crossing (#0022)
Max ozone (ppm)	1500 -1600	0.063	0.112	0.069	not available	0.117	.105
Time of max (military)	0.101	1700 -1800	1300 -1500	1500 -1600		1400 -1500	1500 -1600

These data have not yet been validated and are for internal use only by Sonoma Technology. Do not cite or quote.

Figure 2-4c. Example daily status and data report submitted by the New Mexico Environment Department.

REV 1.09B COPY #10 STATION NO. 06 EL PASO. DOWNTOWN

S/Z CHECK AND CAL DATA

	LAST CAL DATE/TIME	LAST CHECK DATE/TIME	CAL ZERO.	ZERO DRIFT	ZERO P/F	CAL SPAN	SPAN DRIFT	SPAN P/F
CO	0807 1100	0813 1100	32	-4	P	767	-13	P
O3	0807 2300	0813 2300	9	3	P	688	0	P
SO2	0807 1700	0813 1800	16	0	P	341	8	P
NO	0807 2000	0813 2000	8	4	P	677	27	P
NO2	0807 2000	0813 2000	4	6	P	727	6	P
NOX	0807 2000	0813 2000	8	4	P	704	16	P

REV 1.09B COPY #10 STATION NO. 06 EL PASO. DOWNTOWN

HOURLY AVERAGES

DATE AND TIME	WDR DEG	WSR MPH	TEMP DEGF	CO PPB	O3 PPB	SO2 PPB	NO PPB	NO2 PPB
08/13/96 00:00	50	4	79	711	5	6	53	47
08/13/96 01:00	71	3	77	643	5	7	51	52
08/13/96 02:00	76	3	76	808	4	6	35	43
08/13/96 03:00	91	3	75	1160	3	6	42	40
08/13/96 04:00	99	3	74	1935	4	6	62	43
08/13/96 05:00	99	2	73	2169	3	9	72	44
08/13/96 06:00	301	3	73	2669	4	36	125	42
08/13/96 07:00	274	1	77	2792	8	61	136	50
08/13/96 08:00	106	2	79	2211	30	21	38	64
08/13/96 09:00	293	2	84	2166	27	45	45	67
08/13/96 10:00	195	2	86	1660	67	37	20	44
08/13/96 11:00	42	2	88	NVAL	134	20	3	42
08/13/96 12:00	98	3	90	NVAL	114	10	4	32
08/13/96 13:00	129	3	91	1297	114	9	10	36
08/13/96 14:00	96	4	92	1086	112	9	6	29
08/13/96 15:00	131	3	93	1356	70	9	20	34
08/13/96 16:00	145	2	93	1367	60	8	21	33
08/13/96 17:00	192	3	93	1019	56	6	15	28
08/13/96 18:00	141	3	93	936	45	NVAL	11	28
08/13/96 19:00	138	2	91	2328	18	NVAL	13	52
08/13/96 20:00	82	2	89	4544	4	10	NVAL	NVAL
08/13/96 21:00	44	4	86	5668	5	15	NVAL	NVAL
08/13/96 22:00	38	6	84	3565	4	16	54	63
08/13/96 23:00	37	6	81	1714	NVAL	13	41	52
08/14/96 00:00	38	4	81	892	NVAL	11	24	45
08/14/96 01:00	56	3	79	752	4	8	53	47
08/14/96 02:00	62	2	78	647	2	7	59	48
08/14/96 03:00	62	3	76	643	3	6	36	43
08/14/96 04:00	83	3	75	1595	2	8	55	46
08/14/96 05:00	66	4	74	2831	3	10	107	49

Figure 2-4d. Example daily status and data report submitted by the Texas Natural Resources Conservation Commission.

```
—[CHA-DATA.DAT - 8/14/1996 - 09:38:20]————————————[Page 1]——————

DCN#E2> LOGIN
PASSWORD>
 LOGGED IN
DCN#E2> PRINT DAILY

----------------------------------------------------------------------------
----
DAILY SUMMARY     08/13/96     10:00     DAY= 226     CHAMIZAL
----------------------------------------------------------------------------
----

----------------------------------------------------------------------------
----
CHANNEL:       01         02         03         04         05
NAME:         CO         OZONE      BETA       WS         WD
UNITS:        PPM        PPM        UGM3       MPH        DEG
VOLTS FS:     1.000      1.000      5.000      5.000      5.000
SLOPE:        50.00      1.000      500.0      100.0      540.0
INTERCEPT:    .0000      .0000      .0000      .0000      .0000
----------------------------------------------------------------------------
----
08/13 10:00    2.20      .0692        .7->        .0      360.0
08/13 11:00    2.71      .1371       1.7->        .0      360.0
08/13 12:00    1.89      .1352       1.9          .0      360.0
08/13 13:00    1.32C<    .1128C>     2.3          .0      360.0
08/13 14:00     .88C>    .1075       1.8->        .0      360.0
08/13 15:00     .84      .0816       2.0          .0      360.0
08/13 16:00     .77      .0711       1.7          .0      360.0
08/13 17:00     .83      .0657       1.9          .0      360.0
08/13 18:00    1.00      .0521       1.7          .0      360.0
08/13 19:00    1.45      .0319       1.9          .0      360.0
08/13 20:00    3.41      .0031       1.6->        .0      360.0
08/13 21:00    4.74      .0020->     1.2->        .0      360.0
08/13 22:00    5.56      .0019->      .5-<        .0      360.0
08/13 23:00    2.79      .0018->      .0-<        .0      360.0
08/14 00:00     .83      .0024->      .0-<        .0      360.0
08/14 01:00     .25      .0088        .0-<        .0      360.0
08/14 02:00     .14      .0069        .0-<        .0      360.0
08/14 03:00     .74      .0014->      .0-<        .0      360.0
08/14 04:00     .67      .0036->      .0-<        .0      360.0
08/14 05:00    1.98      .0034->      .0-<        .0      360.0
08/14 06:00    3.15      .0017->      .0-<        .0      360.0
08/14 07:00    1.58      .0057        .0-<        .0      360.0
08/14 08:00    1.26      .0124        .0-<        .0      360.0
08/14 09:00     .94      .0240        .6-<        .0      360.0
----------------------------------------------------------------------------
----

DCN#E2>
```

Figure 2-4e. Example daily status and data report obtained via BBS from the El Paso City-County Health and Environmental District.

3. FORECASTING AND GO/NO-GO DECISION-MAKING PROTOCOL

The forecasting and go or no-go decision-making protocol described in this section was followed each day of the intensive period (August 3 to September 21). There was a meteorological and air quality forecast prepared each day. These forecasts and other information on current conditions and operational status were used to decide whether intensive or supplemental sampling would be performed the next day.

3.1 FORECASTING AND DECISION SCHEDULE

TNRCC performed regression analyses of historical meteorological forecast variables versus ozone concentrations. Based on these results and established criteria for high ozone concentrations, TNRCC made an ozone forecast for the El Paso-Ciudad Juarez-Sunland Park area each day and faxed it to STI by 1230 MDT. The STI forecaster also reviewed synoptic conditions and forecasts. In addition, STI obtained and reviewed air quality data from subcontractors and government agencies on a daily basis and faxed the current and previous days' concentrations to TNRCC. Every day, the Observation Coordinator and STI forecaster called the TNRCC forecaster by 1300 MDT to discuss the forecast.

By 1330 MDT, an announcement was placed on a voicemail number stating whether the next day was to be a sampling day and what the preliminary expectation was for the day after. The voicemail system was activated by July 26, 1996. Details of aircraft flight paths were provided directly to the aircraft manager.

3.2 CRITERIA FOR DECISION-MAKING

The following criteria were used to decide whether or not to conduct intensive sampling. When intensive sampling was conducted, it was called an intensive operating period, or IOP. The major categories for decision-making criteria are listed below.

<u>Current and forecasted meteorological conditions</u>. Forecasted meteorological conditions conducive to the formation of high ozone concentrations (100 ppb or greater) were required in order to call an IOP. If the forecast called for moderate ozone (80-100 ppb), supplemental sampling was considered. A copy of a TNRCC forecast form is included as **Figure 3-1**. The bottom left section of the form shows the major meteorological forecast criteria associated with high ozone concentrations: maximum temperature above 93°F, cloud cover scattered or clear, temperature range greater than 25°F, and several wind speed and direction criteria. Forecasters and decision-makers paid special attention to winds, temperature, and cloud cover so that the chances of conducting an IOP on a day with low ozone concentrations were reduced.

El Paso Ozone Forecast Verification for 8/13/96 OAD

ELP	Yesterday Max O3: 80												Max O3: 137	
	FOUS14 - 12Z 8/12/96					FOUS 71 -12Z 8/12/96					Verification			
GMT	WD	WS	Temp	Sky	POP	WD	WS	Temp	RH2	QPF	WD	WS	Temp	Sky
0600	09	8	79	0	0	13	12	27	21	0	20	4	25	0
0700											22	4	24	0
0800											00	0	24	0
0900	04	4	72	0							00	0	24	0
1000											00	0	22	0
1100											03	4	21	0
1200	02	2	68	0	0	13	6	22	26	0	11	6	19	0
1300											11	4	19	0
1400											00	0	24	0
1500	07	4	81	1							14	4	26	0
1600											00	0	28	0
1700											19	9	30	0
1800	14	6	92	0	0	19	4	30	32	0	17	6	31	0
1900											19	7	33	0
2000											11	6	34	0
2100	11	7	97	1							25	3	34	1
2200											27	5	34	1
2300											20	4	34	0
0000	13	6	96	1	3	11	6	33	35	0	29	7	35	0
0100											20	7	34	0
0200											17	7	32	0
0300	11	7	86	1							17	5	30	0
0400											15	6	28	0
0500											15	8	28	0
Prec & Temp:	Temp Min	Temp Max	Temp Range	Sky Avg	POP 12-00Z	Temp Max	Temp Min	Temp Range	RH2 Avg	QPF Total	Temp Min	Temp Max	Temp Range	Sky Avg
	66	100	34	0.7	3	33	22	11	29	0.00	66	95	29	0.1
WChg:	66										Prec Total 12-00Z:			
Wind:	WDR	WSR	WSA	WDV		WDR	WSR	WSA	WDV		WDR	WSR	WSA	WDV
09-12Z	033	3.0	3.0	99							080	1.9	2.5	78
12-18Z	099	2.8	4.0	70							152	3.4	4.1	83
24-Hr	101	4.7	5.5	85		133	6.4	7.0	92		176	2.8	4.2	66

	Crit>	Crit<	Fcst	CDif	Obs	CDif	FDif
Yest O3 125	55		80	25	137	12	-57
Sky Cover		1.5	0.7	0.8	0.1	1.4	0.5
Max Temp	93		100	7	95	2	5
Temp Rng	25		34	9	29	4	5.2
WSA Day		7.0	5.5	1.5	4.2	2.8	1.3
WSA 09-12Z		6.0	3.0	3.0	2.5	3.5	0.5
WSA 12-18Z		6.5	4.0	2.5	4.1	2.4	-0.1

Figure 3-1. Example forecast form submitted by the Texas Natural Resources Conservation Commission.

Current and forecasted air quality conditions. The current and forecasted air quality depended heavily on the current and forecasted meteorological conditions. The goal was to identify periods when ozone concentrations would be 125 ppb or higher.

Review of the frequency of occurrence of ozone episodes and of data regarding previous forecasts versus actual ozone concentrations suggested that sampling should be performed even if forecasted ozone values were below 125 ppb. In 1996 the sampling budget was predicated on up to 10 IOP sampling days. This expenditure goal was not expected to be exceeded when calling IOPs on widespread forecasts of around 100 ppb ozone or higher.

During days prior to an IOP, the forecasted meteorological conditions were the primary method for determining the potential for high ozone on the following day. The current day's ozone concentrations may or may not show evidence of a build-up in ozone concentrations. When an IOP was performed, the decision to continue the IOP was based heavily on the current air quality conditions as well as the forecasted meteorological and air quality conditions.

Additional issues which were considered include the following:

Operational readiness of equipment: In general, it was desirable for all equipment to be operational during an IOP. However, forecasted episodes were not ignored nor IOPs canceled even if a critical piece of equipment was inoperable. Note that many routine measurements were performed on all days, even if an IOP was not called. A schedule of the intensive measurements which were made on IOP days is provided in **Table 3-1**.

Table 3-1. Approximate times of intensive sampling activities during the 1996 Paso del Norte Ozone Study.

Time (MDT)	Activity
0530-0830	Morning aircraft flight
0600-0800	Early-morning surface hydrocarbon/carbonyl sampling
0700-0900	Hot-air balloon flight (if performed)
0800-1000	Morning surface hydrocarbon/carbonyl sampling
1000-1200	Mid-morning surface hydrocarbon/carbonyl sampling
1100-1400	Mid-day aircraft flight
1200-1400	Afternoon surface hydrocarbon/carbonyl sampling
1600-1800	Evening surface hydrocarbon/carbonyl sampling
2100-2330	Night aircraft flight (if performed)

Aircraft logistics: Depending on the number of consecutive flight days and number of flights just completed, the aircraft pilot and equipment operators needed 1 or 2 days without sampling before starting flights again. In addition, routine maintenance, which is a function of flight hours, was required. Every attempt was made to schedule maintenance on non-IOP days. Note that all aircraft sampling was performed on a "weather and safety permitting" basis, and a mission may have been modified or aborted for weather- or safety-related reasons.

3.3 DAILY METEOROLOGICAL AND AIR QUALITY INFORMATION

Each day by 1230 MDT, meteorological and air quality information was provided for forecasting and decision-making. AV, LANL, and STI provided daily equipment status reports along with the previous day's maximum ozone concentrations to the Observations Coordinator by 1230 MDT. In addition, STI had direct access on a daily basis to the previous day’s maximum 1-hour average ozone concentrations measured at sites listed in **Table 3-2**, plus the current day’s maximum ozone concentration for the AV-operated sites through 1200 MDT. This air quality information was obtained via fax and bulletin board systems for about 18 sites located in El Paso-Ciudad Juarez-Sunland Park. With the exception of the New Mexico sites, the previous day’s maximum 1-hour average ozone concentrations were available 7 days per week. The New Mexico data were obtained on weekdays only. The information obtained from the 17 sites was integrated into a previous day’s maximum ozone concentration report; a summary is shown in Appendix A.

The previous day’s maximum 1-hour average ozone concentration report was faxed by STI to TNRCC (Brian Lambeth) and the Observations Coordinator on a daily basis. The daily forecast was faxed by TNRCC to the Observations Coordinator on a daily basis. Several meteorological and air quality observational and forecast products were also available as needed for the forecaster and the Observations Coordinator. Some of these are briefly summarized below:

Observations

- Current and previous day’s maximum 1-hour average ozone concentrations
- Current surface meteorology at NWS (National Weather Service) stations
- Current upper-air data at NWS sites
- Current radar wind profiler data
- Current satellite images (visible and infrared)
- Current radar images

Table 3-2. Sites for which previous day's maximum 1-hour average ozone concentrations were available.

Site	Agency Responsible	Access Medium
University Ave., Las Cruces, NM (NLC)	New Mexico Environment Department	Fax
Las Cruces Holman, NM (NHM)	New Mexico Environment Department	Fax
Chaparral, NM (NCH)	New Mexico Environment Department	Fax
La Union, NM (NLU)	New Mexico Environment Department	Fax
Santa Teresa Border Crossing, NM (NST)	New Mexico Environment Department	Fax
Desert View, NM (NDV)	New Mexico Environment Department	Fax
Sunland Park, NM (NSP)	New Mexico Environment Department	Fax
El Paso CAMS 12 (TUT) UTEP	Texas Natural Resources Conservation Commission	Fax
El Paso CAMS 6 (TED) Downtown Campbell	Texas Natural Resources Conservation Commission	Fax
El Paso CAMS 30 (TEE) Ascarte Park	Texas Natural Resources Conservation Commission	Fax
Chamizal Park (TCH)	El Paso City-County Health and Environmental District	BBS
20-30 Club (M23)	El Paso City-County Health and Environmental District	Fax
Advance Transformer (MJA)	El Paso City-County Health and Environmental District	Fax
Franklin Mountain (FKM)	AeroVironment	Fax
Winn Road (WIN)	AeroVironment	Fax
Turf Road (TRF)	AeroVironment	Fax
Dyer Street (DYR)	AeroVironment	Fax

Forecast discussion products

- NWS forecast discussion
- Previous day's ozone forecast verifications
- 12-, 24-, 36-, and 48-hour forecasts for winds, max/min temperatures, clouds
- Extended range (48 to 120 hour) forecast discussions

Forecast products

- Spectral, MRF, NGM, and Eta forecast for 12-, 24-, 36- and 48-hours
- NGM and Eta model output data for El Paso

3.4 DAILY FORECASTING AND DECISION-MAKING ACTIVITIES

The decision to conduct an IOP or supplemental sampling was based on the forecasted and current air quality and meteorological conditions and on other criteria listed in Section 3.2. This section discusses the activities leading up to and including a decision to conduct supplemental or IOP sampling in the El Paso-Ciudad Juarez-Sunland Park area.

A daily schedule of forecasting and decision-making activities is shown in **Table 3-3**. These activities proceeded on all days during the intensive field study (August 3 through September 21). The activities in Table 3-3 are described in greater detail below.

Table 3-3. Schedule of daily forecasting and decision-making activities.

Time (MDT)	Activity (Responsibility)
	Before Conference Call
1230	Fax previous day's maximum ozone summaries to Observations Coordinator (AV, TNRCC, El Paso City-County Health and Environmental Department, NM Environment Department)
1230	Fax previous day's maximum ozone summaries TNRCC (STI Operations Center)
1230	Fax forecast to Observations Coordinator (TNRCC)
1100-1300	Review forecasts, summaries, recent profiler data (TNRCC and STI staff)
1200-1300	Summarize operational status, meteorological forecast, existing ozone concentrations, and history of IOP sampling episodes to date (Observations Coordinator and STI staff)
1300-1330	Discuss potential decision and decide on IOP status
1330	After Conference Call
	Notify sampling personnel of IOP decision (Observations Coordinator)
	Post IOP decision on message machine (Observations Coordinator)
	If Go decision, begin preparations for sampling (sampling personnel)

A conference call occurred each day, beginning by 1300 MDT. The goal of the conference call was to review all data and forecasts and to decide whether or not to conduct an IOP or supplemental measurements on the next day and to assess the possibilities for the following days. During the conference call, the Observations Coordinator and the forecasters reviewed the operational status, meteorological and air quality forecasts, and history of IOP sampling to date. Based on the discussions, the Observations Coordinator then decided on an IOP for the next day. After the conference call, the Observations Coordinator posted the decision on the El Paso-Ciudad Juarez-Sunland Park message machine so that others could phone in and learn the IOP status. It was the responsibility of each organization to call the message machine and obtain the decision for the next day.

4. SUMMARY OF THE 1996 OZONE EPISODES IN THE EL PASO-CIUDAD JUAREZ-SUNLAND PARK AREA

This section provides a summary of the 1996 ozone exceedances in the El Paso-Ciudad Juarez-Sunland Park area and the intensive measurements made as part of the summer ozone study. The data presented in this section are raw, Level 0, unreviewed data. They are incomplete and may contain errors. The quality-specified data from the study should be available later this year.

4.1 SUMMARY OF OZONE EPISODES

From the data we have received to date, the National Ambient Air Quality Standard (NAAQS) for ozone was exceeded on only one day in the El Paso-Ciudad Juarez-Sunland Park area during the 1996 study period. Ozone concentrations reached 100 ppb or higher on seven days during the routine sampling period of July 21 to September 23. The maximum measured 1-hour average ozone concentration during the study period was 137 ppb at Chamizal Park, El Paso on August 13. Additional information regarding peak observed ozone concentrations is presented below; Appendix A provides a preliminary summary of maximum ozone concentrations from July 20 to September 21, 1996.

August 13, 1996 Ozone Episode

The maximum measured 1-hour average ozone concentration was 137 ppb at Chamizal Park, El Paso on August 13. Three other sites also exceeded the NAAQS for ozone, including El Paso CAMS 12, El Paso CAMS 6, and 20-30 Club. At five additional sites, the ozone concentration reached 100 ppb or more, including La Union, NM, Santa Teresa, NM, Desert View, NM, Sunland Park, NM, and Franklin Mountain. Data were incomplete at the Franklin Mountain site, therefore, the peak ozone concentration may have been higher than measured at that site. **Table 4-1** lists the air quality sites with ozone concentrations greater than or equal to 100 ppb for the August 13 episode.

September 4, 1996

There were no exceedances of the ozone NAAQS on September 4; however, the second highest daily ozone maximum concentration observed during the IOP forecasting period occurred on this date. The maximum 1-hour average ozone concentration was 117 ppb at the Advance Transformer, Juarez site. The measured ozone concentration reached 100 ppb or higher at only one other site: Chamizal Park, El Paso where the concentration reached 116 ppb.

Table 4-1. Air quality sites in the El Paso-Ciudad Juarez-Sunland Park area with ozone concentrations greater than or equal to 100 ppb during the August 13, 1996 episode. Data shown are unreviewed, Level 0. They are incomplete and may contain errors.

Site Name	State	Ozone Max. (Level 0 Data) (ppb)
La Union	NM	101
Santa Teresa	NM	105
Desert View	NM	117
Sunland Park	NM	112
El Paso UTEP CAMS 12	TX	126
El Paso Downtown CAMS 6	TX	134
El Paso Chamizal Park	TX	137
20-30 Club	MX	129
Franklin Mountain	TX	115*

* Incomplete data at Franklin Mountain. Maximum ozone concentration may be higher.

August 17, 1996

There were no exceedences of the ozone NAAQS on August 17; however, the third highest daily ozone maximum concentration observed during the IOP forecasting period occurred on this date. The maximum 1-hour average ozone concentration was 105 ppb at the Desert View, NM site. The measured ozone concentration reached 100 ppb or higher at only one other site: El Paso CAMS 12 where the concentration reached 103 ppb.

4.2 SUMMARY OF INTENSIVE MEASUREMENTS

Continuous air quality and meteorological measurements were conducted at the surface air quality and meteorological, radar profiler, and sodar sites throughout the El Paso-Ciudad Juarez-Sunland Park area from late July through mid-September, as discussed in earlier sections. Additional measurements were made at the surface and aloft on IOP days and some additional days (see Table 2-5).

Tables 4-2 and 4-3 summarize the intensive aircraft, hydrocarbon, and carbonyl measurements made as part of the summer ozone study. Table 4-2 lists the number of aircraft flights performed, the number of hydrocarbon and carbonyl samples collected on each flight, and the route flown. Table 4-3 lists the number of hydrocarbon and carbonyl samples collected at each surface air quality research station.

Table 4-2. Number of hydrocarbon and carbonyl samples collected during each aircraft flight of the 1996 Paso del Norte Ozone Study.

Date	Flight	No. HC Samples Collected	No. Carbonyl Samples Collected
8/11/96	Night	0	0
8/12/96	Morning IOP	5	5
8/12/96	Afternoon IOP	5	5
8/12/96	Night	0	0
8/13/96	Morning IOP	5	5
8/13/96	Afternoon IOP	5	5
9/2/96*	Supplemental	3	3
9/4/96*	Supplemental	3	3
9/5/96*	Morning IOP	5	5
9/5/96*	Afternoon IOP	5	5
9/6/96*	Supplemental	3	3
9/7/96*	Supplemental	3	3
9/9/96*	Supplemental	3	3
9/10/96*	Supplemental	3	3
9/13/96*	Afternoon IOP	5	5
9/16/96*	Supplemental	3	3
9/17/96*	Supplemental	3	3
9/18/96*	Supplemental	3	3
9/20/96*	Supplemental	3	3
9/21/96*	Morning IOP	5	5
9/21/96*	Afternoon IOP	5	5
	Totals	75	75

* Number of samples not yet confirmed for these dates.

Table 4-3. Number of surface hydrocarbon and carbonyl samples collected during the 1996 Paso del Norte Ozone Study.

Date	No. of HC/Carbonyl Samples Collected			
	El Paso CAMS 6 (TED)	20-30 Club (M23)	Turf Road (TRF)	Winn Road (WIN)
8/11/96	5/0	5/0	5/6	5/5
8/12/96	5/0	5/0	5/5	5/5
8/13/96	5/0	5/0	5/5	5/5
8/14/96	5/0	5/0	5/5	5/5
9/5/96	5/0	5/0	5/5	5/5
9/13/96	5/0	5/0*	5/5	5/5
9/16/96	5/0	5/0*	5/5	5/5
9/17/96	5/0	5/0*	5/5	5/5
9/18/96	5/0	5/0*	5/5	5/5
9/21/96	5/0	5/0*	5/5	5/5
Totals	50/0	50/0	50/51	50/50

* Number of samples not yet confirmed for these dates.

5. REFERENCES

Bowen J.L. (1996a) Quality assurance project plan for El Paso-Ciudad Juarez-Sunland Park Ozone Field Study. Draft report prepared for U.S. Environmental Protection Agency, Region 6, Dallas, TX under subcontract to SAIC, McLean, VA by Desert Research Institute, Reno, NV, DRI No. 6829-1D1, August.

Bowen J.L. (1996b) Addendum to quality assurance project plan for El Paso-Ciudad Juarez-Sunland Park Ozone Field Study. Draft report prepared for U.S. Environmental Protection Agency, Region 6, Dallas, TX under subcontract to SAIC, McLean, VA by Desert Research Institute, Reno, NV, DRI No. 6829-1D1, August.

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Zielinska B. (1996) Paso Del Norte Pilot Border Study of ozone precursors and air toxics. Draft final report prepared for TRC Environmental Corporation, Chapel Hill, NC by Desert Research Institute, Reno, NV, EPA Contract 68-D3-0029, Work Assignment 2-105, February.

APPENDIX A

MAXIMUM HOURLY AVERAGED OZONE AT AIR QUALITY MONITORING SITES DURING THE 1996 PASO DEL NORTE OZONE STUDY

(Note that these data are raw, unreviewed, preliminary, Level 0 data. They are incomplete and may contain errors; changes in the data may occur.)

El Paso-Ciudad
Juarez-Sunland Park Ozone Study
Forecast Worksheet
Observed Ozone Concentration (ppb)

		7/20/96	7/21/96	7/22/96	7/23/96	7/24/96	7/25/96	7/26/96	7/27/96
	Intensive Operations (Y/N)								
ID	**Site Name**								
NLC	University Avenue, Las Cruces	52	55	53	72	79	79	63	44
NHM	Las Cruces Holman, NM	52	65	62	84	75	71	71	53
NCH	Chaparral, NM	106	68	76	65	61	66	73	47
NLU	La Union, NM	57	60	58	79	95	89	81	53
NST	Santa Teresa, NM	56	62	59	72	77	82	64	57
NDV	Desert View, NM	57	64	61	79	-999	88	79	56
NSP	Sunland Park, NM	58	62	58	75	95	86	74	51
TUT	El Paso UTEP CAMS 12, TX						74	67	45
TED	El Paso Downtown CAMS 6, TX	57	63	63	62	57	75	62	50
TCH	El Paso Chamizal Park, TX	65					59	-999	37.6
M23	20-30 Club, MX	66	84	70	65	57	66	56	41
MJA	Advance Transformer, MX				56	81	65	56	43
MJT	Tecno (Chihuahua State Tech. Inst.)								
FKM	Franklin Mountain	55	60	70	64	68	78	55	
TEE	El Paso East (Ascarte Park), TX	117	65	64	62	60	69		
WIN	Winn Road (southeast)	58	63	69	63	67	76	52	53
TRF	Turf Road (east)	104	83	84	73	63	72	55	55
DYR	Dyer Road (north)	12	50	51	42	44	46	47	50
	Maximum Ozone	117	84	84	84	95	89	81	57
	# sites >=100 ppb	3	0	0	0	0	0	0	0
	# sites >=125 ppb	0	0	0	0	0	0	0	0

IOP = Intensive operating period
SF = Supplemental aircraft flights
HCs = Surface hydrocarbon/carbonyl sampling

-999 = Data not available
* = Data incomplete

IF = Instrument failure
PF = Power failure
CD = Computer down (lost data)

El Paso-Ciudad
Juarez-Sunland Park Ozone Study
Forecast Worksheet
Observed Ozone Concentration (ppb)

		7/28/96	7/29/96	7/30/96	7/31/96	8/1/96	8/2/96	8/3/96	8/4/96
	Intensive Operations (Y/N)								
ID	**Site Name**								
NLC	University Avenue, Las Cruces	43	47	51	50	52	41	56	27
NHM	Las Cruces Holman, NM	49	51	63	64	65	56	62	43
NCH	Chaparral, NM	43	65	-999	63	67	58	62	39
NLU	La Union, NM	-999	77	71	63	65	60	61	42
NST	Santa Teresa, NM	58	62	68	60	59	58	59	38
NDV	Desert View, NM	58	77	81	62	63	60	60	39
NSP	Sunland Park, NM	54	77	77	57	60	59	58	37
TUT	El Paso UTEP CAMS 12, TX	46	68	77	60	63	46	47	36
TED	El Paso Downtown CAMS 6, TX	54	69	80	56	-999	41	45	32
TCH	El Paso Chamizal Park, TX	41.6	53.8	72	58.8	55	-999	54	34
M23	20-30 Club, MX	44	57	86	68	67	55	-999	37
MJA	Advance Transformer, MX	44	54	69	83	69	59	63	42
MJT	Tecno (Chihuahua State Tech. Inst.)					-999	-999	-999	-999
FKM	Franklin Mountain	54	75	-999	-999	-999	63	-999	43
TEE	El Paso East (Ascarte Park), TX	45	56	80	90	73	57	58	40
WIN	Winn Road (southeast)	49	55	98	110	101	70	69	46
TRF	Turf Road (east)	52	-999	89	69	105	68	70	49
DYR	Dyer Road (north)	47	64	-999	-999	-999	54	57	46
	Maximum Ozone	58	77	98	110	105	70	70	49
	# sites >=100 ppb	0	0	0	1	2	0	0	0
	# sites >=125 ppb	0	0	0	0	0	0	0	0

IOP = Intensive operating period
SF = Supplemental aircraft flights
HCs = Surface hydrocarbon/carbonyl sampling

-999 = Data not available
* = Data incomplete

IF = Instrument failure
PF = Power failure
CD = Computer down (lost data)

El Paso-Ciudad
Juarez-Sunland Park Ozone Study
Forecast Worksheet
Observed Ozone Concentration (ppb)

		8/5/96	8/6/96	8/7/96	8/8/96	8/9/96	8/10/96	8/11/96	8/12/96
	Intensive Operations (Y/N)							**IOP**	**IOP**
ID	**Site Name**								
NLC	University Avenue, Las Cruces	37	37	48	40	37	50	50	57
NHM	Las Cruces Holman, NM	45	65	50	49	49	54	55	72
NCH	Chaparral, NM	45	45	50	43	47	53	54	62
NLU	La Union, NM	45	46	60	47	52	75	65	80
NST	Santa Teresa, NM	41	39	57	51	60	79	64	79
NDV	Desert View, NM	43	64	60	47	55	99	61	77
NSP	Sunland Park, NM	44	43	57	44	50	87	53	68
TUT	El Paso UTEP CAMS 12, TX	39	38	50	41	41	91	54	67
TED	El Paso Downtown CAMS 6, TX	30	30	42	36	34	88	66	62
TCH	El Paso Chamizal Park, TX	39	20	44	34	43	87	57	65
M23	20-30 Club, MX	42	-999	45.6	38.5	47	90	69	71
MJA	Advance Transformer, MX	48	45	51.8	45.8	53	89	53	76
MJT	Tecno (Chihuahua State Tech. Inst.)	-999	-999	-999	-999	-999	-999	-999	-999
FKM	Franklin Mountain	62	48	-999	-999	53	61	60	53
TEE	El Paso East (Ascarte Park), TX	44	46	50	40	46	78	55	58
WIN	Winn Road (southeast)	61	59	54.9	47.8	42	72	71	73
TRF	Turf Road (east)	80	64	54.2	53	53	67	78	73
DYR	Dyer Road (north)	52	51	57.8	44.7	47	54	61	69
	Maximum Ozone	80	65	60	53	60	99	78	80
	# sites >=100 ppb	0	0	0	0	0	0	0	0
	# sites >=125 ppb	0	0	0	0	0	0	0	0

IOP = Intensive operating period
SF = Supplemental aircraft flights
HCs = Surface hydrocarbon/carbonyl sampling

-999 = Data not available
* = Data incomplete

IF = Instrument failure
PF = Power failure
CD = Computer down (lost data)

El Paso-Ciudad
Juarez-Sunland Park Ozone Study
Forecast Worksheet
Observed Ozone Concentration (ppb)

		8/13/96	8/14/96	8/15/96	8/16/96	8/17/96	8/18/96	8/19/96	8/20/96
	Intensive Operations (Y/N)	**IOP**	**HCs**						
ID	**Site Name**								
NLC	University Avenue, Las Cruces	63	58	55	57	55	50	50	43
NHM	Las Cruces Holman, NM	69	67	69	73	64	66	67	54
NCH	Chaparral, NM	76	64	65	68	59	66	84	48
NLU	La Union, NM	101	87	95	67	81	60	59	65
NST	Santa Teresa, NM	105	81	83	61	96	61	57	62
NDV	Desert View, NM	117	79	83	75	105	63	59	63
NSP	Sunland Park, NM	112	82	76	76	98	62	58	57
TUT	El Paso UTEP CAMS 12, TX	126	82	62	101	103	59	58	51
TED	El Paso Downtown CAMS 6, TX	134	70	62	88	90	59	54	45
TCH	El Paso Chamizal Park, TX	137	64	64	94	93	64	62	46
M23	20-30 Club, MX	129	67	62	94	95	66	64	48
MJA	Advance Transformer, MX	93	67	62	102	95	64	69	52
MJT	Tecno (Chihuahua State Tech. Inst.)	-999	-999	-999	-999	-999	-999	-999	-999
FKM	Franklin Mountain	115 *	69	69	93	88	68	66	54
TEE	El Paso East (Ascarte Park), TX	81	56	61	84	83	68	68	48
WIN	Winn Road (southeast)	70	67	62	100	90	92	94	55
TRF	Turf Road (east)	79	68	67	85	77	105	97	70
DYR	Dyer Road (north)	94	74	74	95	68	75	94	53
	Maximum Ozone	137	87	95	102	105	105	97	70
	# sites >=100 ppb	9	0	0	3	2	1	0	0
	# sites >=125 ppb	4	0	0	0	0	0	0	0

IOP = Intensive operating period
SF = Supplemental aircraft flights
HCs = Surface hydrocarbon/carbonyl sampling

-999 = Data not available
* = Data incomplete

IF = Instrument failure
PF = Power failure
CD = Computer down (lost data)

El Paso-Ciudad
Juarez-Sunland Park Ozone Study
Forecast Worksheet
Observed Ozone Concentration (ppb)

		8/21/96	8/22/96	8/23/96	8/24/96	8/25/96	8/26/96	8/27/96	8/28/96
	Intensive Operations (Y/N)								
ID	**Site Name**								
NLC	University Avenue, Las Cruces	54	46	44	30	28	32	42	23
NHM	Las Cruces Holman, NM	52	60	61	39	36	31	40	33
NCH	Chaparral, NM	43	-999	51	34	32	35	32	29
NLU	La Union, NM	63	59	52	38	41	47	37	28
NST	Santa Teresa, NM	54	52	48	41	32	38	42	29
NDV	Desert View, NM	61	55	47	38	42	47	40	29
NSP	Sunland Park, NM	61	54	46	37	39	48	37	23
TUT	El Paso UTEP CAMS 12, TX	52	47	38	30	28	38	28	22
TED	El Paso Downtown CAMS 6, TX	43	43	41	33	34	37	27	18
TCH	El Paso Chamizal Park, TX	40	43	36	27	28	41	26	22
M23	20-30 Club, MX	46	45	40	29	28	41	30	23
MJA	Advance Transformer, MX	48	55	46	34	30	36	36	27
MJT	Tecno (Chihuahua State Tech. Inst.)	-999	-999	-999	-999	-999	-999	-999	-999
FKM	Franklin Mountain	49	59	43	35	32	44	32	29
TEE	El Paso East (Ascarte Park), TX	44	48	45	30	26	43	31	24
WIN	Winn Road (southeast)	50	57	52	35	30	38	37	38
TRF	Turf Road (east)	49	60	53	36	30	38	31	27
DYR	Dyer Road (north)	53	59	57	39	31	49	34	33
	Maximum Ozone	63	60	61	41	42	49	42	38
	# sites >=100 ppb	0	0	0	0	0	0	0	0
	# sites >=125 ppb	0	0	0	0	0	0	0	0

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El Paso-Ciudad
Juarez-Sunland Park Ozone Study
Forecast Worksheet
Observed Ozone Concentration (ppb)

		8/29/96	8/30/96	8/31/96	9/1/96	9/2/96	9/3/96	9/4/96	9/5/96
	Intensive Operations (Y/N)					SF		SF	IOP
ID	**Site Name**								
NLC	University Avenue, Las Cruces	44	43	42	48	42	40	40	45
NHM	Las Cruces Holman, NM	46	61	53	62	55	56	59	55
NCH	Chaparral, NM	45	44	61	68	56	51	80	70
NLU	La Union, NM	44	57	46	52	49	48	56	72
NST	Santa Teresa, NM	48	68	46	57	50	46	47	46
NDV	Desert View, NM	48	72	46	58	53	49	73	72
NSP	Sunland Park, NM	45	66	44	55	48	44	68	50
TUT	El Paso UTEP CAMS 12, TX	38	40	40	49	-999	-999	48*	45
TED	El Paso Downtown CAMS 6, TX	36	57	46	56	49	39	87	57
TCH	El Paso Chamizal Park, TX	-999	50	48	48	46	41	116	-999
M23	20-30 Club, MX	44	58.6	46	59	43	43	106	53
MJA	Advance Transformer, MX	47	60.3	46	50	53	47	117	52
MJT	Tecno (Chihuahua State Tech. Inst.)	-999	-999	-999	-999	-999	-999	-999	-999
FKM	Franklin Mountain	63	58.8	48	52	48	46	76	59
TEE	El Paso East (Ascarte Park), TX	44	PF	PF	PF	PF	45	80	CD
WIN	Winn Road (southeast)	51	53	55	60	58	54	70	48
TRF	Turf Road (east)	43	41.7	86	70	80	63	67	59
DYR	Dyer Road (north)	54	52.2	71	67	71	58	92	85
	Maximum Ozone	63	72	86	70	80	63	117	85
	# sites >=100 ppb	0	0	0	0	0	0	3	0
	# sites >=125 ppb	0	0	0	0	0	0	0	0

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		9/6/96	9/7/96	9/8/96	9/9/96	9/10/96	9/11/96	9/12/96	9/13/96
	Intensive Operations (Y/N)	**SF**	**SF**		**SF**	**SF**			**IOP**
ID	**Site Name**								
NLC	University Avenue, Las Cruces	40	41	42	44	42	38	40	56
NHM	Las Cruces Holman, NM	-999	44	51	48	55	40	45	56
NCH	Chaparral, NM	82	45	66	49	52	38	45	59
NLU	La Union, NM	44	52	66	58	59	40	61	49
NST	Santa Teresa, NM	42	48	63	61	60	47	51	69
NDV	Desert View, NM	46	61	65	61	62	52	66	61
NSP	Sunland Park, NM	41	56	57	56	58	42	59	55
TUT	El Paso UTEP CAMS 12, TX	81*	83	48	47	47	34	48	47
TED	El Paso Downtown CAMS 6, TX	46*	71	56	50	48	39	47	IF
TCH	El Paso Chamizal Park, TX	61	69	47	49	-999	-999	-999	64
M23	20-30 Club, MX	77	98	49	46	50	38	51	74
MJA	Advance Transformer, MX	73	77	52	51	54	43	53	93
MJT	Tecno (Chihuahua State Tech. Inst.)	82	86	49	46	-999	-999	-999	-999
FKM	Franklin Mountain	58	69	49	50	52	42	51	95
TEE	El Paso East (Ascarte Park), TX	IF	IF	IF	IF	IF	IF	IF	IF
WIN	Winn Road (southeast)	42	40	31	30	31	25	29	56
TRF	Turf Road (east)	89	99	51	57	59	48	65	66
DYR	Dyer Road (north)	94	77	52	57	60	45	59	70
	Maximum Ozone	94	99	66	61	62	52	66	95
	# sites >=100 ppb	0	0	0	0	0	0	0	0
	# sites >=125 ppb	0	0	0	0	0	0	0	0

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El Paso-Ciudad
Juarez-Sunland Park Ozone Study
Forecast Worksheet
Observed Ozone Concentration (ppb)

		9/14/96	9/15/96	9/16/96	9/17/96	9/18/96	9/19/96	9/20/96	9/21/96
	Intensive Operations (Y/N)			IOP	IOP	IOP		SF	IOP
ID	**Site Name**								
NLC	University Avenue, Las Cruces	34	38	29	27	25	44	45	52
NHM	Las Cruces Holman, NM	43	47	40	38	36	51	55	60
NCH	Chaparral, NM	50	49	37	36	33	49	59	58
NLU	La Union, NM	48	48	34	32	32	47	57	55
NST	Santa Teresa, NM	37	45	36	33	34	46	57	56
NDV	Desert View, NM	46	47	37	34	33	48	58	58
NSP	Sunland Park, NM	46	45	36	32	30	45	56	57
TUT	El Paso UTEP CAMS 12, TX	40	26	18	28	24	38	41	51
TED	El Paso Downtown CAMS 6, TX	28	26	29	24	19	29	33	43
TCH	El Paso Chamizal Park, TX	36	42	34	22	28	45	50	
M23	20-30 Club, MX	38	42	36	31	28	44	50	57
MJA	Advance Transformer, MX	37	44	37	36	33	45	52	68
MJT	Tecno (Chihuahua State Tech. Inst.)	-999	-999	-999	-999	-999	-999	-999	-999
FKM	Franklin Mountain	43	43	38	32	36	45	-999	-999
TEE	El Paso East (Ascarte Park), TX	IF	IF	IF	IF	IF	IF	IF	IF
WIN	Winn Road (southeast)	22	32	28	27	21	30	27	45
TRF	Turf Road (east)	46	55	55	57	50	59	65	84
DYR	Dyer Road (north)	53	57	49	46	42	54	65	85
	Maximum Ozone	53	57	55	57	50	59	65	85
	# sites >=100 ppb	0	0	0	0	0	0	0	0
	# sites >=125 ppb	0	0	0	0	0	0	0	0

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